MULTIMEDIA UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 2, 2019/2020**

## TIC2151 THEORY OF COMPUTATION

(All sections / Groups)

29 FEBRUARY 2020
9.00 am – 11.00 am
(2 Hours)

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**INSTRUCTIONS TO STUDENTS**

1. This Question paper consists of 3 pages only excluding the cover page.
2. Attempt all questions. The distribution of the marks for each question is given.
3. Please write your answers in the answer booklet provided. Please write the question number of each answer clearly.

# QUESTION (1)

**NOTE: Attempt any THREE out of FOUR Parts (A), (B), (C) and (D).**

(A)

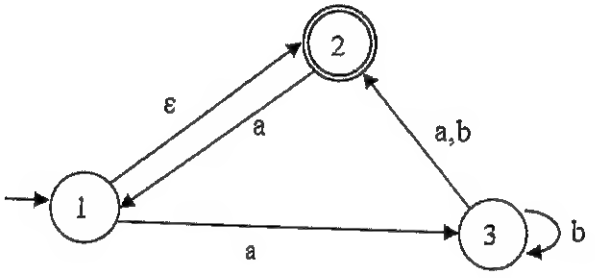
1. Prove by construction that If $n$ is an odd positive integer, then $n^2$ is odd. [2 marks]
2. Let $r$ be a rational number and $x$ is an irrational number. Proof by contradiction that: $r + x$ is irrational. [3 marks]

(B) Draw state diagrams for DFAs accepting the following languages:

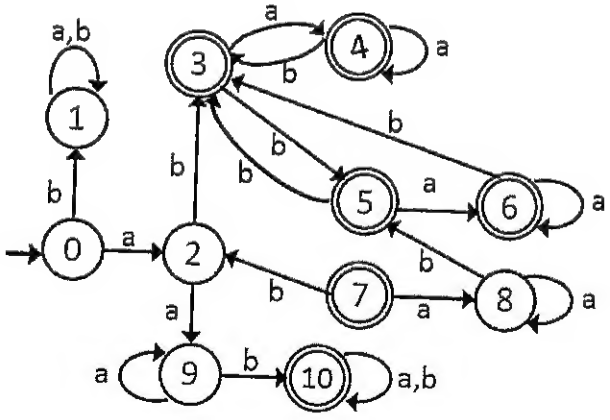
$L_1 = \{w \in \{a, b\}^* \mid w \text{ starts and ends with same letter}\}$. [2.5 marks]

$L_2 = \{w \in \{0, 1\}^* \mid w \text{ does not end with } 01\}$ [2.5 marks]

(C) Convert the following NFA into an NFA without ε-transitions. Show both transition tables (with and without ε-transitions) and the corresponding state diagram. [5 marks]




(D) Minimize the following DFA. Show your steps. [5 marks]



## QUESTION (2)

(A)

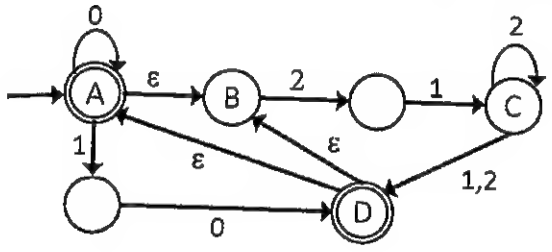
1. Determine the language corresponding to each of the following regular expressions:
   i. $(1 + 0)^* 0 (1 + 0)^* 0 (1 + 0)^* 1$ [1.5 marks]
   ii. $(a + b)^+ aba (a + b)^+$ [1.5 marks]
2. Find regular expressions corresponding to each of the following languages.
   i. $L = \{ w \in \{0,1\}^* \mid$ every odd position of w is a 0 $\}$ [1.5 marks]
   ii. $L = \{ w \in \{0,1\}^* \mid$ string w starts with 01 and has an even length $\}$ [1.5 marks]

(B) Convert the following regular expression into an NFA. Follow the construction rules closely and do not just give a simpler NFA even though it is possible. [4 marks]

$$(((10)^* + (01)^*)\ 00)$$

(C)

1. What is the regular grammar corresponding to the NFA given below? [2 marks]




2. Give the regular grammars corresponding to each of the following languages over the alphabet {a, b}.

   $L_1 = bb (ab)^* + aa (ba)^*$ [1.5 marks]

   $L_2 = a (a + b)^+ b + b(a + b)^+ a$ [1.5 marks]

## QUESTION (3)

(A) Construct a PDA for each of the following languages:

$L_1 = \{a^n b^{2n+1} \mid n > 0\}$ [3 marks]

$L_2 = \{w \in \{0, 1\}^* \mid$ the length of w is odd and its middle symbol is a 0$\}$ [3 marks]

(B) The following CFG grammar is in Chomsky normal form, use the Cocke-Younger-Kasami (CYK) algorithm to determine whether the words ***bacabbab*** and ***acbacabca*** can be derived from this grammar or not. Show your proof.

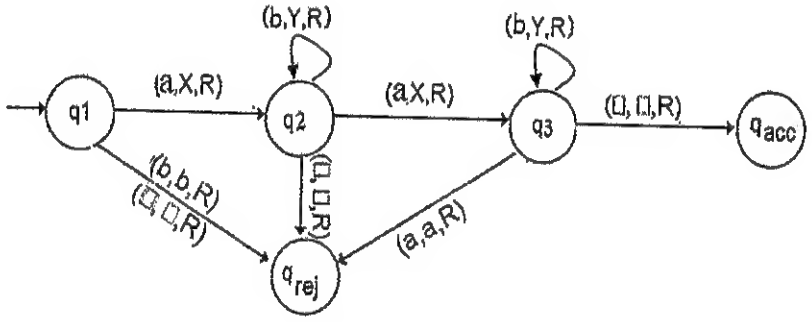
S → a | AB | SC
A → b
B → SA
C → DS
D → c

[4 marks]

## QUESTION (4)

**NOTE: Attempt any TWO out of THREE Parts (A), (B) and (C).**

(A) Given the following Turing Machine:




1. What language does the Turing Machine accept? Give the language in regular expression form. [1 mark]
2. Give the formal definition of the Turing Machine including the transition table. [4 marks]

(B) Construct a Turing Machine for the language $L = \{0^m 1 0^n 1^n \mid n, m \geq 1\}$. [5 marks]

(C) Consider the language:

$A_{RE} = \{\langle R, w\rangle \mid R$ *is a regular expression that generates string* $w\}$.

Is $A_{RE}$ a TM decidable or undecidable language? Prove your answer. [5 marks]

**End of page.**